CHAPTER 4

Air Toxics

The Air Toxics Program

Background

Hazardous air pollutants, also commonly referred to as air toxics, are pollutants which cause, or may cause, severe health effects or ecosystem damage. Examples of air toxics include dioxins, benzene, arsenic, beryllium, mercury, and vinyl chloride. The Clean Air Act (CAA) lists 188 pollutants as hazardous air pollutants (HAPs) and targets them for regulation in section 112 (b)(1) of the CAA. Air toxics are emitted from all types of sources, including large industrial sources, small stationary sources, and mobile sources.

Control of air toxic pollutants differs in focus from control of the six principle NAAQS pollutants. For the six NAAQS pollutants, control strategies are used in geographic areas where the national air quality standards have been violated. In contrast, EPA has focused on identifying the sources of air toxics and developing nationwide technology-based performance standards for these sources. The objective is to ensure that sources of air toxic pollution are as well controlled as technology will allow regardless of geographic location.

The air toxics program and the NAAQS program complement each other. Many air toxics are emitted in the form of particles or as organic compounds. Control efforts to meet the NAAQS for ozone and PM-10 can also reduce air toxic emissions. Further, as air pollution control strategies for automobiles become more stringent, air toxic emissions that can result from vehicles are also reduced. Requirements under the air toxics program can also significantly reduce emissions of some of the six NAAQS pollutants. For example, EPA's final air toxics rule for organic chemical manufacturing is expected to reduce VOC emissions (which form ozone or ground-level smog) by nearly 1 million tons annually. Also, the implementation of programs requiring the use of reformulated gasoline may have resulted in the significantly reduced benzene concentrations discussed in Chapter 3 of this report.

The air toxics program is especially important in reducing air emissions at or near isolated industrial locations and in controlling pollutants that are toxic even when emitted in small amounts. Additionally, EPA has developed mechanisms to prevent sudden, catastrophic releases like the Bhopal chemical plant explosion in 1985. Companies handling or using toxic chemicals are required by EPA to develop programs to prevent accidental releases and to contain any releases in the event they should occur.

Health Effects

At sufficient concentrations and exposure durations, human health effects from air toxics can include cancer, poisoning, and immediate illness. Other less measurable effects include immunological, neurological, reproductive, developmental, and respiratory effects. Hazardous air pollutants may also be deposited onto soil or into water bodies, thereby affecting ecological systems and eventually human health.

In addition to inhalation exposure from HAPs, indirect exposures from some HAPs can occur particularly through the ingestion of food. These HAPs can bio-accumulate in body tissues and magnify up the food web, meaning each level accumulates the toxics and passes the burden along to the next level of the food web. Top consumers in the food web, usually consumers of large fish, may accumulate chemical concentrations many millions of times greater than the concentrations present in the

water. As a result, fish consumption advisories have been issued in hundreds of water bodies nationwide, including the Great Lakes. Adverse effects range from immune system disease and reproductive problems in wildlife to subtle developmental and neurological impacts on children and fetuses.

Ecological effects attributable to bio-accumulating HAPs can be subtle or delayed in onset. These effects include immune function impairment, reproductive problems, and neurological changes—all of which can affect population survival.

Emissions Sources

There are approximately 4.4 million tons of air toxics released to the air each year. Due to the considerable uncertainty in evaluating these pollutants, the air toxics issue has been described more often in qualitative, rather than quantitative, terms. In addition, ambient concentration data for individual air toxic pollutants is limited (both spatially and temporally) in comparison to the long-term nationwide monitoring for the six criteria pollutants. For these reasons, characterization of the air toxics issue in this chapter relies on emissions data. However, it is important to note that in an effort to understand the ozone problem, EPA is beginning to develop a monitoring strategy to evaluate ambient concentrations of certain ozone-forming VOCs. Photochemical Assessment Monitoring Stations (PAMS) collect data on concentrations of ozone and its precursors. Because many ozone precursors are also air toxics, ambient data collected from PAMS sites is being used to evaluate the toxics problem as well as the ozone problem. Preliminary analysis of measurements of individual VOCs in urban areas classified as serious, severe, or extreme ozone nonattainment areas indicate that concentrations of certain toxic VOCs in those areas appear to be declining. In particular, benzene levels showed a significant decline between 1994 and 1995 (38 percent), possibly as a result of the use of reformulated gasoline in those areas. It should be noted that PAMS measurements have only been taken for three years, and that continuing efforts in the PAMS program will provide more confidence in evaluating the long-term trends of benzene and other VOCs. For a more detailed discussion of the PAMS program, see Chapter 3 of this report.

The Office of Air Quality Planning and Standards (OAQPS) is currently developing a National Toxics Inventory (NTI) which includes all of the 188 hazardous air pollutants (HAPs, as identified in the CAA) emitted from 796 categories of point, area, and mobile sources[1]. Data from the Toxic Release Inventory (TRI) were used as the foundation of this inventory. However, TRI data are significantly limited in several key aspects as a tool for comprehensively characterizing the scope of the air toxics issue. For example, TRI does not include estimates of air toxics emissions from mobile and area sources[2]. Therefore, NTI has incorporated other data to create a more complete inventory[3]. Data resulting from EPA studies required by sections 112k and 112(c)(6) of the CAA as well as the Mercury Study, the Utility Air Toxics Study, and data used to develop Maximum Achievable Control Technologies (MACT) standards, have been incorporated into NTI. In addition, state and local data such as the California Air Resources Board's (CARB) Hot Spots Report have been used in NTI.

NTI and its use of non-TRI data represent a significant improvement in the characterization of the air toxics issue. As shown in Figure 4-1, NTI indicates that area sources account for approximately 31 percent of toxic emissions, and mobile sources account for 39 percent of toxic emissions (relative to the 188 listed HAPs). Further, NTI suggests that TRI data alone represent less than half of the total emissions from the point source category. Further analyses based on NTI data for a list of 37 selected toxics pollutants are summarized below.

Table 4-1 provides information on the effects associated with each pollutant and the current NTI annual emissions estimate for each pollutant. In addition, Table 4-1 identifies those hazardous air pollutants that are also tropospheric ozone and/or particulate matter

precursors. It should be noted that these 37 pollutants account for approximately 86 percent of the total annual emissions of the 188 listed HAPs. Figure 4-2 shows the geographic distribution of total toxic pollutants by state for high, medium, and low emissions categories. Table 4-2 lists the 20 top emitting source categories for 37 pollutants including point, area and mobile sources. These 20 source categories account for 79 percent of toxic emissions (relative to the listed HAPs). As mentioned earlier, area, and mobile sources collectively account for 70 percent of toxic emissions; in fact, the first two source categories, on-road motor vehicles and residential wood combustion, account for approximately 47 percent of the HAPs emitted annually.

Air Toxics Regulation and Implementation Status

The 1990 CAAA greatly expanded the number of industries affected by national air toxic emissions controls. The emissions reductions from these controls are just beginning to be realized for some industries. Large industrial complexes (major sources) such as chemical plants, oil refineries, marine tank vessel loading, aerospace manufacturers, steel mills,

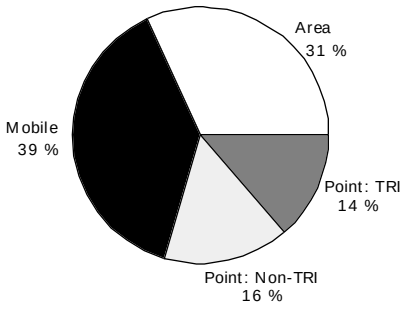

Figure 4-1. *HAP emissions by source category, 1990.*

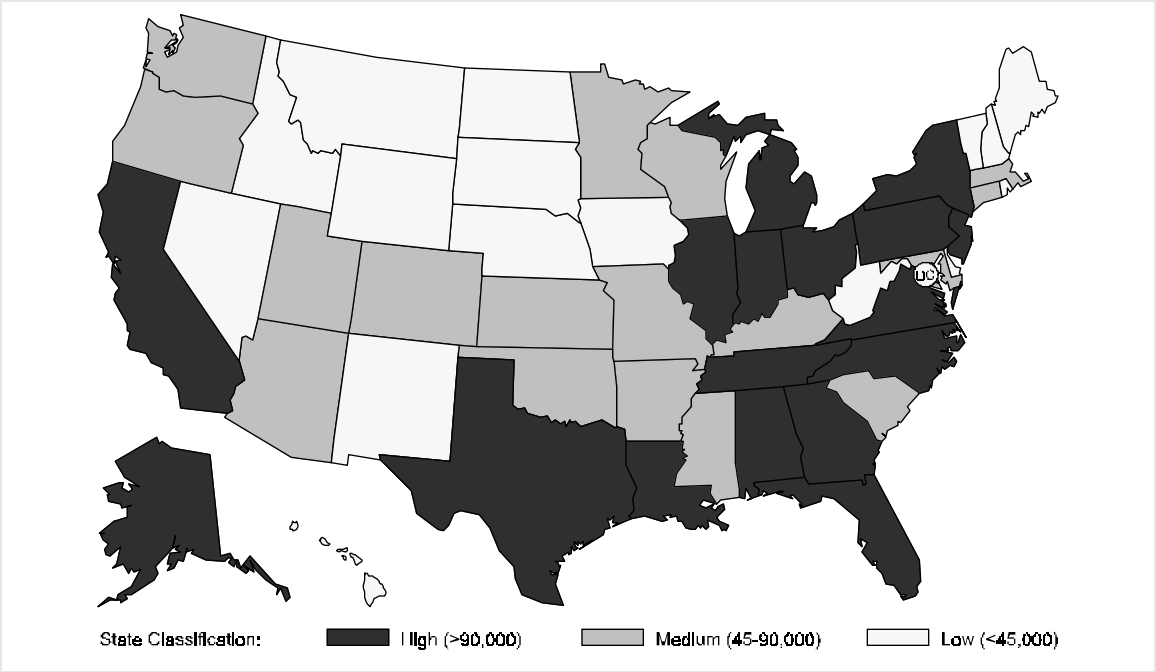

Figure 4-2. *HAP emissions by state, 1990.*

Table 4-1. *37 Toxic Pollutants—Ranked by Annual Emissions Totals*

Pollutant	Highly Toxic Pollutant[a]	Environmentally Persistent[b]	Effects from Acute Exposure	Ozone Precursor	PM or PM Precursor	National Emissions (tons/year)
Toluene				x	x	1.22E+06
POM (PAHs)	x	x		x	x	7.53E+05
Benzene	x			x		5.72E+05
Formaldehyde			x	x		2.81E+05
Xylenes				x	x	1.87E+05
1,3-Butadiene	x			x		1.23E+05
Tetrachloroethylene			x			1.09E+05
Acetaldehyde				x		9.53E+04
Trichloroethylene				x		5.33E+04
Acrolein	x		x	x		4.93E+04
Methylene chloride		x				4.34E+04
Hydrazine	x			x		3.94E+04
Glycol ethers				x		2.30E+04
Styrene				x		1.67E+04
Arsenic compounds	x	x			x	1.36E+04
Chloroform		x		x		6.93E+03
Nickel compounds	x	x			x	5.36E+03
Lead compounds	x	x			x	3.76E+03
Manganese compounds	x	x			x	1.70E+03
Ethylene dichloride	x			x		1.27E+03
Bis(2-chloroethyl) ether	x					7.90E+02
Cadmium compounds	x	x			x	7.90E+02
Acrylonitrile	x			x		6.98E+02
Ethylene oxide	x	x	x	x		6.52E+02
Vinyl chloride	x			x		5.17E+02
Chromium compounds	x	x			x	2.94E+02
MDI	x			x		2.73E+02
Mercury compounds	x	x			x	2.46E+02
2,4-Toluene diisocyanate	x		x	x		4.50E+01
Antimony compounds	x	x				2.18E+01
Ethylene dibromide	x					1.68E+01
Acrylamide	x			x		1.44E+01
Beryllium compounds	x	x				9.29E+00
Phosgene	x	x	x	x		2.85E+00
2,3,7,8-TCDF	x			x	x	1.44E-02
2,3,7,8-TCDD	x			x	x	1.56E-03
Coke oven emissions	x				x	*

* Coke oven gas emissions not included in Version 2 of the National Toxic Inventory.

a Highly toxic HAP are those HAP with a reference concentration of less than $5.0E\text{-}03^{-3} mg/m^3$ (noncancer effects); a weight of evidence classification of A (known human carcinogen) or B1 (probable human carcinogen); or, a verified unit risk estimate of greater than $2.0\ E\text{-}05^{-5}$ $(ug/m^3)^{-1}$ and a weight of evidence classification of A or B.

b HAP for which there is potential for persistence in the environment of greater than 14 days.

and a number of surface coating operations are some of the industries being controlled for toxic air pollution. Where warranted, smaller sources (area sources) of toxic air pollution such as dry cleaning operations, solvent cleaning, commercial sterilizers, secondary lead smelters, and chrome plating are also affected. Within the next 10 years, the air toxics program is projected to reduce emissions of toxic air pollutants by well over 1.5 million tons annually.

Emissions Reductions through Air Toxics Regulation

The regulation of air toxics emissions through the process outlined in Section 112 of the 1990 CAAA, referred to as maximum achievable control technology (MACT) regulations, is beginning to achieve significant emissions reductions of HAPs as well as criteria pollutants. As Figure 4-3 shows, as of October 1996 MACT standards have been promulgated for 47 source categories, representing all MACT standards in the 2- and 4-year groups. Sources are required to comply with these standards within 3 years of the effective date of the regulation, with some exceptions. EPA estimates reductions of 983,000 tons per year in HAP emissions and reductions of about 1,810,000 tons per year from the combined emissions of PM-10 (a criteria pollutant) and volatile organic compounds (ozone precursors).

The MACT standards producing these emissions reductions are listed in Figures 4-4 and 4-5, along with an estimate of the associated HAP reductions unique to each standard. The 10 MACT standards in Figure 4-4, which are collectively responsible for the majority of the HAP emissions decreases, individually produce reductions ranging from 7,000 to 506,000 tons per year. The 10 MACT standards in Figure 4-5 reduce emissions of hazardous air

Table 4-2. *Top 20 Sources of Toxic Emissions for 37 Toxic Pollutants, 1990*

Rank	NTI Source Category Description	Total Annual Emission of the 37 Toxic Pollutants (tons/year)
1	On-road motor vehicles	1.52E+06
2	Residential wood combustion	5.25E+05
3	Glycol dehydrators	2.45E+05
4	Consumer and commercial product solvent use	2.22E+05
5	Non-road mobile vehicles	2.09E+05
6	Forest fires	1.91E+05
7	Prescribed burning	1.31E+05
8	Industrial wood waste combustion	9.93E+04
9	Dry cleaning	8.98E+04
10	Halogenated solvent cleaning	5.77E+04
11	Utility coal combustion	3.96E+04
12	Gasoline distribution; stage II	2.27E+04
13	Primary aluminum production	1.80E+04
14	Industrial coal combustion	1.69E+04
15	Manufacture of motor vehicles and car bodies	1.51E+04
16	Gasoline distribution, stage 1	1.37E+04
17	Plastics foam products	1.36E+04
18	Commercial printing, gravure	1.27E+04
19	Pulp mills	1.21E+04
20	Structure fires	1.18E+04

pollutants which have very significant health impacts such as dioxin, chromium, lead, mercury, cadmium, arsenic, coke oven emissions, 1,3-butadiene, and benzene.

The specific pollutants whose emissions are reduced by the MACT program are detailed in Table 4-3 and further in the Table A-21 in the Data Appendix. In Table 4-3, the standards listed control one or more of the specified pollutants. Those pollutants that are potentially controlled by a standard are designated by an "x". Some of these HAPs are of particular interest to the special studies discussed in the next section.

Special Studies

As required by the 1990 CAAA, EPA is also conducting special studies to assess the magnitude and effects of air toxics focusing on specific sources, receptors, and pollutants. Summaries of examples of such examinations are presented below.

The Great Waters Study

Section 112(m)(5) of the CAA requires a study and reports to Congress every two years assessing the extent of atmospheric deposition of HAPs and other pollutants to the Great Lakes, the Chesapeake Bay, Lake Champlain, and coastal waters, and the need for new regulations to protect these water bodies. The pollutants of concern to this effort include nitrogen compounds, mercury, and pesticides in addition to other HAPs. There are extensive research programs underway through this program to provide new understanding of the complicated issue of atmospheric deposition of air pollution to water bodies. New scientific findings will be incorporated into each required biennial report to Congress and appropriate regulatory recommendations will be made based on those findings. This statute provides the authority to introduce new regulations or influence those under development in order to prevent adverse effects from these pollutants to human health and the environment.

Utility Air Toxics Study

As mandated by Section 112(n)(1)(A) of the CAA, the Agency is studying HAP emissions from fossil fuel fired (coal, oil, and gas) electric utilities and the associated hazards to public health. A draft utility report identifies 67 HAPs in the emissions database. The report predicts that in the next two decades, there will be

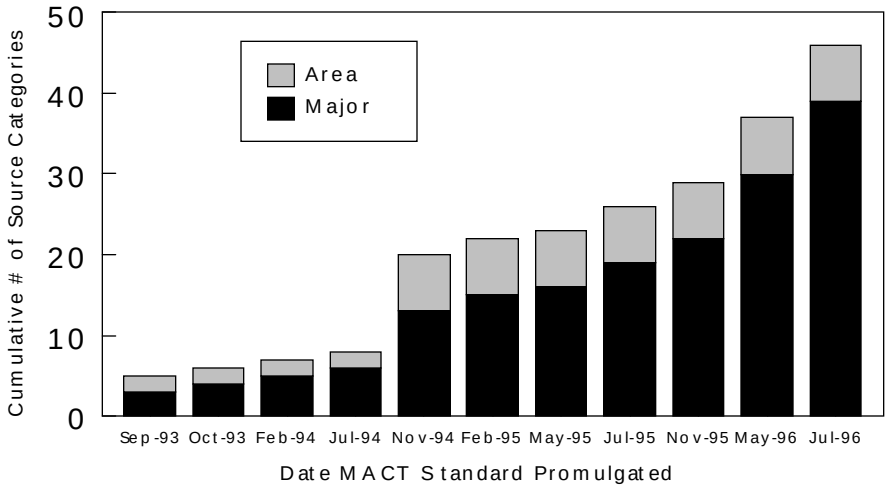

Figure 4-3. *MACT source categories.*

Table 4-3. *Major Pollutants Controlled by Promulgated MACT Standards (All 2- and 4-Year Standards)*

MACT or Sec. 129 Standard	Pollutant					
	Chromium	Metals (Pb, Hg, Cd, As) & Compounds	Coke Oven Emiss, POM Naphthalene	TCE, Perc, 111-TCA Carbon Tet. Chloroform Methylene Chloride Methyl Chloride	Benzene Toluene Xylenes Ethyl-Benzene Styrene	Hexane
Perc Dry Cleaning				x		
Coke Ovens			x			
HON			Many HAPs Are Controlled			
Ind Cooling Twrs	x					
Comm Sterilizers						
Chromium Elec.	x					
Magnetic Tape					x	
Stage I Gaso Mkt					x	
Degreasers				x		
P & R II						
Secondary Lead		x				
Petro Refineries					x	
Aerospace	x		x	x		
Marine Tank Vess					x	x
Wood Furniture					x	
Shipbuilding					x	
Off-Site Waste			x	x	x	
Printing & Pub					x	
Poly & Resins IV					x	
Poly & Resins I				x	x	x

Note: The demarkation "x" implies that the standard controls one or more of the specified pollutants.

roughly a 30 percent increase in HAP emissions from coal-fired utilities and roughly a 50 percent decline in HAP emissions from oil-fired utilities. These projections are primarily based on anticipated energy demands and changes in fuel usage, but also account for other factors such as expected controls.

The Mercury Study

The Mercury Study is a comprehensive study of mercury emissions from anthropogenic sources in the United States, an assessment of the public health and ecological effects of such emissions, an analysis of technologies to control mercury emissions, and the costs of such control. The study is mandated by section 112(n)(1)(B) of the CAA. A number of observations can be made regarding trends in mercury emissions. The overall consumption of mercury is generally declining in industrial or manufacturing sources that use mercury. Industrial consumption of mercury has declined by about a third between 1988 and 1993. Much of this decline can be attributed to the elimination of mercury as a paint additive and the reduction of mercury in batteries. Reducing mercury in manufactured products is important because emissions of mercury are likely to occur when these products are broken or discarded. Based on trends in mercury use, EPA predicts that manufacturing use of mercury will continue to decline with chlorine production from mercury cell chlor-alkali plants. These plants continue to account for most of the use in, and emissions from, the manufacturing sector. Secondary production of mercury will continue to increase as more recycling facilities begin operations to recover mercury from

Table 4-3. *Major Pollutants Controlled by Promulgated MACT Standards (All 2- and 4-Year Standards) (continued)*

MACT or Sec. 129 Standard	Pollutant								
	Epichlorohydrin Chloroprene	1,3-Butadiene	Ethylene Oxide	MEK MIBK	Ethylene Glycol Glycol Ethers	Methanol Formaldehyde Acetaldehyde	Acrylonitrile	HCl	Dioxane
Perc Dry Cleaning									
Coke Ovens									
HON	Many HAPs Are Controlled								
Ind Cooling Twrs									
Comm Sterilizers			x						
Chromium Elec.									
Magnetic Tape				x					
Stage I Gaso Mkt									
Degreasers									
P & R IIx									
Secondary Lead		x							
Petro Refineries									
Aerospace				x					
Marine Tank Vess									
Wood Furniture				x	x	x			
Shipbuilding				x	x				
Off-Site Waste				x		x			
Printing & Pub				x	x	x			
Poly & Resins IV		x			x	x	x		x
Poly & Resins I	x	x					x	x	

Note: The demarkation "x" implies that the standard controls one or more of the specified pollutants.

discarded products and wastes. A significant decrease will occur in mercury emissions from municipal waste combustors and medical waste incinerators if the regulations proposed by EPA for these source categories are fully implemented. Based on predictions in energy demands and fuel usage, mercury emissions from utility boilers are expected to increase. The Mercury Study is expected to be completed in 1999.

The Specific Pollutants Strategy

Section 112(c)(6) of the CAA requires EPA to identify the sources of 90 percent of air emissions of alkylated lead compounds, polycyclic organic matter, hexachlorobenzene, mercury, polychlorinated biphenyls, 2,3,7,8-tetrachlorodibenzofurans, and 2,3,7,8-tetrachlordibenzo-p-dioxin. The Agency is required to develop a strategy to promulgate standards for these sources by the year 2000.

The Urban Area Source Program

Section 112(k) of the CAA requires EPA to develop a strategy that will subject the sources of HAP emissions in urban areas to standard controls and thereby reduce cancer risk from those HAPs by 75 percent. Research to determine which HAPs and sources will be included in the strategy are currently under development.

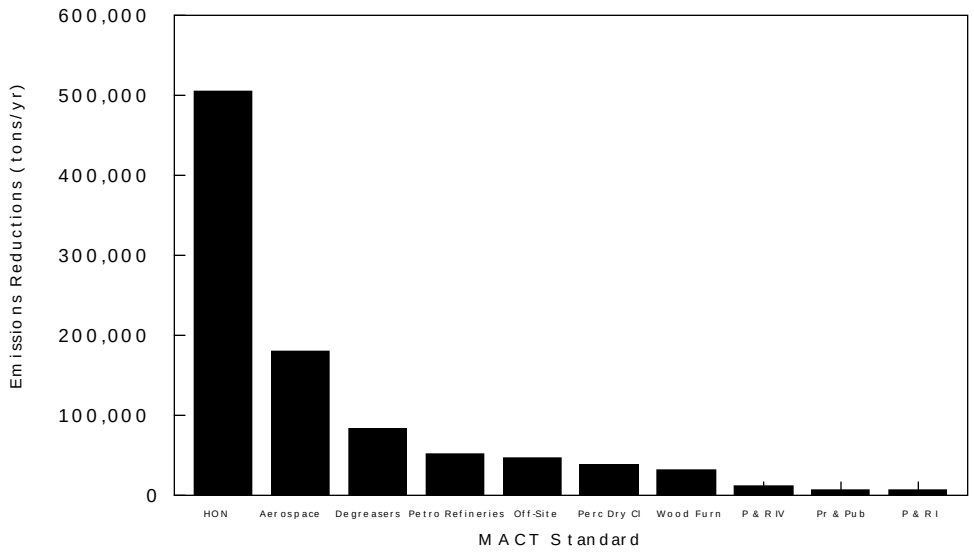

Figure 4-4. *Emissions reductions, >5000 tons per year. (See Table 4-3 for a listing of MACT standards.)*

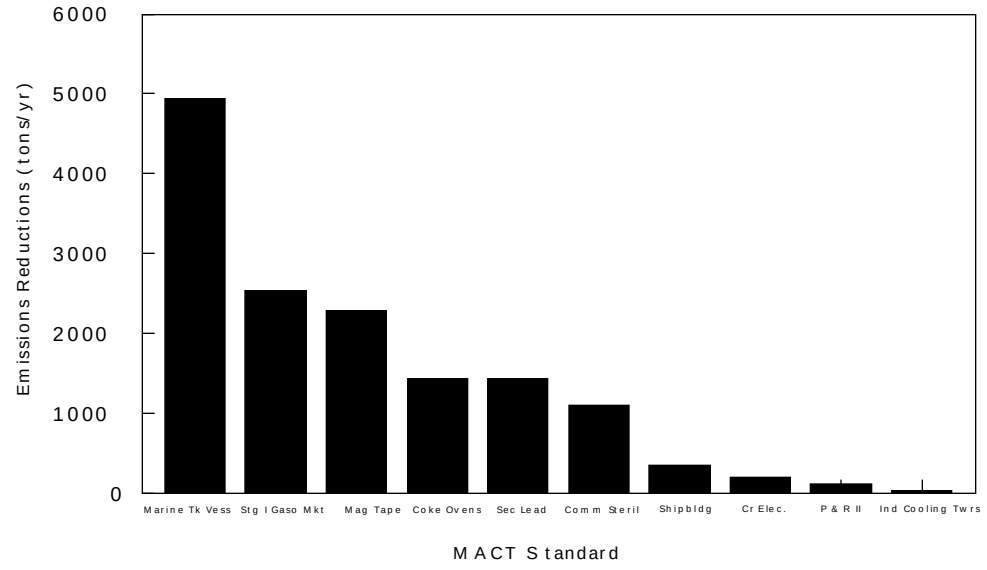

Figure 4-5. *Emissions reductions, <5000 tons per year. (See Table 4-3 for a listing of MACT standards.)*

Notes

1. This report references the number of hazardous air pollutants identified in Section 112(b)(1) of the Clean Air Act as 188 rather than 189 (as in previous reports) due to the Agency's modification of the list to remove caprolactam (Hazardous Air Pollutant List; Modification, 61 FR 30816, June 18, 1996).

2. In addition to the absence of emissions estimates for area and mobile source categories, there are other significant limitations in the inventory's portrayal of overall HAP emissions. First, facilities with Standard Industrial Classification (SIC) codes outside the range of 20 to 39 (the manufacturing SIC range) are not required to report. Therefore, HAP emissions from facilities such as mining operations, electric utilities, and oil and gas production operations are not represented in the TRI. Further, TRI data are self-reported by the emitting facilities, and TRI does not require facilities to perform any actual monitoring or testing to develop their TRI estimates. Consequently, the accuracy of the reported data may vary from facility to facility and year to year. Finally, the original TRI list only required reporting for 173 of the 188 HAPs identified in the CAAA.

3. It should be noted that the National Toxics Inventory (NTI) is a work in progress and additional Maximum Achievable Control Technology (MACT) studies still need to be added along with state and local toxic inventory data and results from Title V surveys.